Artificial Intelligence Based Control Power Optimization on Tailless Aircraft

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Purpose

This project investigates the potential of applying artificial intelligence methods like neurocomputing to the control allocation optimization problem of Hybrid Wing Body (HWB) aircraft concepts. Researchers from NASA Langley, Virginia Tech, and Boeing Research and Technology are exploring the use of artificial neural networks to develop innovative control algorithms minimizing control power, hinge moments, and actuator forces to keep system weights within acceptable limits.

HWB platforms feature multiple control surfaces, with large control surface geometries leading to large hinge moments and high control power demands. Due to the large number of control surfaces on an HWB, there is no unique relationship between control inputs and resulting aircraft response, i.e. different combinations of flap deflections may potentially result in the same maneuver, but with large differences in control power.

While traditional methods of control allocation optimization may have limitations in exploiting the full potential of controlling large arrays of control devices, artificial neutral networks (ANN) are inspired by biological nervous systems and have successfully been applied to a variety of complex optimization problems.

This project employs a finite element based aeroelastic HWB model, wind tunnel and flight test data to develop a database that can be used to develop an artificial neural network (ANN) to perform control allocation optimization for tailless aircraft at the conceptual design level.

Background

The use of artificial intelligence to overcome the shortcomings of conventional methods for control allocation has not been explored to a significant extent in the open literature. A literature search yielded very few results, most of them not applicable to this critical need for HWB configurations. Artificial intelligence offers new ways to optimize control power while minimizing hinge moments and structural loads.

HWB aircraft concepts offer the potential to achieve significant fuel burn savings of 25% and more, emissions reductions, and community noise benefits, therefore countering the impact of drastic increases in future air traffic volume. Recent wind tunnel testing suggests that control authority issues still exist (e.g. stall recovery and three-dimensional coupling effects). Stability augmentation and control power optimization for these aircraft concepts can be enablers for their success.

The proposed concept applies to the design and development stages of future air vehicles. If the research proves successful, artificial intelligence will be used to develop optimized control laws in a much more efficient manner than by using traditional methods; and such optimized control laws are an enabler for an entire fleet of revolutionary aircraft. Without the necessity to implement artificial intelligence on the aircraft itself, no certification issues are associated with such a solution.